LECTURES TO SANITARY OFFICERS.

HOUSE DRAINAGE.

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(FELLOW.)

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THE Lecturer said his subject was house drainage, as distinguished from any sewer or sewer connection, and presumed that the sewage was carried away and disposed of beyond the confines of the premises drained. Drainage in its simple meaning was the conveyance of liquid from where it was not wanted to where it was wanted, or to where it is harmless. Drainage must conform to the rules which govern all sanitary arrangements, namely, that foul matter should be conveyed away as quickly as possible, and that the production of bad gases should be prevented. These two rules might be looked upon as a guide when judging of an appliance as to its suitability and fitness.

The first thing to do in dealing with house drains was to shorten and simplify them as much as possible. Having marked out the line of drains suitable to the building to be dealt with, it should first be ascertained how much fall was available, or what incline could be given to the drains. The fall required in drainage, especially in house drains, was determined by the power of water to move foreign substances through the pipes. Experiments had shown that one foot per second would move sand and grit, and small particles of that kind; two feet per second would generally move rounded pebbles; and three feet per second would move angular stones. A velocity which would move angular stones would move also conglomeration of organic matter found in house drains. Drains, therefore, should be capable of giving a velocity of three feet per second to the sewage running in them. A rough rule by which could be ascertained the capacity of drains in respect of velocity was to multiply the diameter by ten, and allow for a fall of one for the figure so obtained, namely, a four inch drain should have a fall of one in forty, a six inch, one in sixty, and a nine inch, one in ninety or a hundred. These inclines were based on the assumption that no larger amount of sewage running in the drains

than would usually come down them. Whenever drain pipes were running half full, or more than half full, a much flatter incline could be given. It was not the general experience to find drains running more than a quarter or one-third full, therefore, the inclines mentioned should be adhered to as nearly as possible. When the drains run cleanly with the ordinary amount of sewage coming away from a house and keep themselves clean, they were said to be self-cleansing. If they were not self-cleansing they would require a forced velocity, either effected by the discharge of a flushing tank or by some appliance made to discharge with great velocity into their head. Thus, it was a great advantage to have the outlet of a bath of a large diameter, so that the bath water might specially flush the drains.

In the ordinary house the size of a drain was generally a matter of rule of thumb, that is to say, 4-in. pipes were put in for the smaller branch drains, and 6-in. pipes for the main drains, and those sizes were generally sufficient. Only when dealing with larger buildings than an ordinary house would the size of the drains have to be considered. The rainfall would affect the size of the drains, but it was only of importance in buildings where there was a large roof or hard surface. In these cases about one inch of rain per hour was the right amount to allow for. This amount, however, should not be confused with that to be allowed in the case of towns, where there were open spaces gardens or roads, which drained into the river or surface water drains; but in dealing with such places as barracks, institutions, and so on, an inch of rain per hour should be allowed for in calculating the diameter of the ordinary drain. For ordinary houses 4-in. drains for small branches, and 6-in. for the main drain, could be with safety adhered to.

Sometimes people thought benefit would be derived by separating slop water from the actual soil sewage, but this was a wasteful way to arrange drainage, for in point of foulness the slop water from sinks and similar places was as bad as any sewage, thus there was no benefit gained in separating the slop water from the usual soil water.

In laying out a system of drains it is now usual to lay them in straight lines; this might seem hardly consistent with regard to what had been said as to making drains as short as possible, because it would be easier to shorten drains by laying them in curves round a house than by laying them in straight lines; but the difference between a curved line and a number of straight lines inclined to suit the direction in which the sewage would go was not great, and it had been undoubtedly proved that the best and most correct method of laying drains was to lay them in straight lines. The old way of laying drains was to get close to

the cesspool or sewer, to dig a portion of a trench, put in a pipe, throw the earth from the next length of trench back over the portion just laid and so on, and coming up to the building somewhere, the level did not matter, so long as the two ends of the drain were open, it was hoped the drainage would get away. This method was not now tolerated. Now drains were laid from point to point with the fall that was available, and properly apportioned between the various parts. The trenches dug would not be simply left as opened, but the bottoms would be carefully formed to a true incline; also, if the ground were found to be treacherous, concrete, or something which would form a firm foundation, would be put in. It was especially necessary to guard drains passing close to a building, where there was a basement, so that the sewage would not leak from a higher level into the ground surrounding the basement. Therefore, all drains which were bound to run at a high level round a house having a basement, were specially cased or made of iron.

Drains were usually made of stoneware; the best material was composed of Devon and Dorset clays, which were derived from disintegrated granite chiefly; but there was other material, such as the Midland fireclay, which was often passed off as the genuine article, and specifications should specially state whether drains were to be of stoneware from Devon and Dorset clays, or whether they were to be of Midland fireclay. There was a great difference in the material. For ordinary drains where there was no great pressure Midland fireclay stoneware was good enough, but where drains had to be laid at great depths it would be found that unless the pipes were very strong and specially packed with concrete they would crush. He had found large numbers of drains crushed by the weight of the superincumbent earth. A good way of trying the material of a pipe was to break a piece off and wet it. If the moisture disappears quickly it was a rather soft fireclay; if it stayed and shone the material would be impervious or a true stoneware, or nearly approaching it. In making stoneware drains or pipes it was found that the clay cockled and twisted in burning, and therefore the length of each pipe was not more than 2-ft., 2-ft. 6-in., or 3-ft. as a rule, depending on the diameter of the pipes. Smaller sized pipes, such as the 3-in. and 4-in., would be 2-ft. long; 6-in. and 9-in., 2-ft. 6-in. to 3-ft.; and 12-in. pipes may be 3-ft. long. Hence it could be realised what a large number of joints there must be in the drain, and this constituted a difficulty in getting them sound and watertight.

The ordinary drain pipe was laid with a cemented joint, but it was found in practice that the British workman, whether on purpose or accidentally,

made such bad work with the ordinary cemented joint that he often brought into disgrace the whole drainage system, necessitating it being reconstructed. To avoid these difficulties a good many patent joints had been made, the earliest being the Stanford Joint, which consisted of a ring of bitumen tapered on the inside, cast in the socket of the ordinary pipe, and a corresponding ring cast on the spigot of the pipe which had to fit into that socket. These were cast in truly turned moulds, and the consequence was that with a little grease they fitted exactly, similarly to a turned and bored joint. It was found, however, that although these made excellent joints to begin with, in the course of time they became leaky, not from decomposition in the material, because they had been found to stand almost anything that could come down, except perhaps extremely hot water, say when a boiler was emptied, but more probably, he thought, from the expansion and contraction of pipes under different temperatures of sewage. However that might be, the fact remained that these joints did not remain tight, and they brought great discredit on engineers when the drains were tested after they had been laid a year or two. To get over this difficulty Messrs. Doulton brought out a joint very similar, but instead of being wedge shape so as to jamb together, the fitting surface of the material in the socket was made parallel, while the material on the spigot was cast with a spherical surface. This was supposed to enable the pipe not only to expand and contract, but if the ground sunk a little it would enable the pipe joint to move without any leakage taking place. That joint seemed to get over some of the difficulty, but it could readily be seen that if it depended upon the nicety with which one pipe could slide up inside another, there would be a difficulty in making that joint quite watertight. Moreover in drainage it was not desirable to allow for the sinking of the ground, for this should be prevented by forming a concrete bed. Therefore the advantages of that particular joint were not very apparent, especially when it was remembered that there was no other sealing except the bitumen to keep the drain pipe tight. An improvement on that plan was where the bitumen was put into the spigot and socket, as in the case of the Stanford pipe, but the socket was made deeper and undercut, so that when the pipes were put together they were concentric, as in the case of the Stanford and Doulton joints, but made absolutely tight by cement put over afterwards. Another joint was called the Archer joint, with a rather complicated spigot and socket, round which was placed clay to form a joint temporarily, and then cement was poured in at a hole at the top, so as to run round the space between the two flanges. Well, the cement

did run round and it did not. In the larger pipes that joint seemed to work pretty well, but in the smaller pipes it was not trustworthy. The Hassell joint was similar to the last, but had bitumous rings to take the place of the clay lining, and the cement was poured round. This joint also gave both good and bad results. Then there were screw pipes which resembled the screw stoppers of beer bottles. These pipes found favour with some engineers, but the lecturer had no experience of them.

Now a good pipe was capable of standing a considerable head of water as a test. Nearly always it would be found that these pipes bled or sweated through some little pores, and if a pipe was suspected of being porous, the best plan was to test it before it was put in and not afterwards, because the porosity of the pipe would prevent complete information being obtained as to whether the joints were tight. The test applied to drains when they were laid was to plug them at the bottom and fill them with water. Some people thought this was too severe a test, but it was to be remembered that when a drain got stopped and the sewage backed up in the pipes, the drain was undergoing a similar strain to that of the water test, and he thought therefore that it was not too severe a test for house drains. Under the house the drains should be specially secure, and owing to the difficulty of getting stoneware pipes and joints sound, it was now usual to have, for the sake of security, heavy iron pipes under the house similar in quality to those used for water mains.

In the system of laying drains straight from point to point, it was usual to provide at those points where the drains deflect, or turn sideways, means of access. The larger means of access was a manhole, constructed generally of brick, and closed by a cover which might be readily

This cover, although removable, is locked and firmly fastened when closed.

FIG. 1.

ANGELL'S MANHOLE COVER.

opened (figs. 1, 2, 3). These manholes should be big enough when deep to allow a man to get into them to work, but if it was not necessary for the man to get in, they might be of any size sufficient to allow the channel to

be nicely laid in the bottom with the proper curve. The cover of a manhole was important because it must always be readily opened, and yet not so loose that it may let out foul air. In the old days manholes and

FIG. 2.

TREW'S MANHOLE COVER.

covers, and everything of that sort, appeared to be an extravagant nuisance, but after a little experience of builders' men coming and pulling up the whole of the ground and path to find the drains, it did not appear

FIG. 3.

CONDENSATION MANHOLE COVER.

to be such an extravagant idea, especially in these days when wages were rising by leaps and bounds. A good many covers had been invented,

some simple, and some complicated, but the object of most of them was to get them air-tight. Some were made air-tight by the use of gaskin, grease, sand, or mercury. There was objection to most of these. Grease appeared to evaporate in time, gaskin got picked up or stuck to the lid, and was lost; sand got washed out, and mercury was stolen because of its value. The cover that met the difficulty best was that which was origin-

FIG. 4.

BUCHAN'S DISCONNECTING TRAP.

ally brought out by J. Jones, of Chelsea (fig. 3). It consisted of two

FIG. 5.

"BEANCLIFF" DISCONNECTING TRAP.

covers, the inner one formed in the shape of a dome. This cover took

advantage of the moisture which was always suspended in the warm air of a sewer, and which, on meeting a colder surface, would condense. The moisture collected on the dome ran down the slope, and got into the channel all round. The result was that there was a water seal, and although water might evaporate, it would always be replenished by moisture condensed from the warm air of the sewer. This, he thought, was undoubtedly the best security there was. It used to be expensive, but the patents had now run out, and the cover could be obtained cheaply. *not run out several years to run.*

With regard to manholes provision had to be made for drains passing through them at the bottom cleanly without splashing. The bottoms should be made with channels variously curved to suit the direction of the meeting drains. It was not sufficient to make a bed with a rough bottom, because if that were done foul matter would collect and contravene one of the rules laid down for good sanitation. Minor means of access to drains took the form of small chambers with light covers, also specially constructed stoneware arrangements such as the Tron and Armstrong junctions and chambers. Frequently also it was desirable as a means for cleaning drains with rods, to provide a junction on the drain with the arm set vertically, surrounded with concrete and covered with a stone.

FIG. 6.

WEAVER'S DISCONNECTING TRAP.

Turning to the question of the prevention of the accumulation of foul gases, the point was how to ventilate drains. There were two ways of ventilating drains, one was by having ventilating openings on their course as was done in the case of sewers in towns, this might be described as "Go as you please ventilation," that did very well for sewers or drains that are in open places. It would also seem to be tolerated in the streets, and he was bound to say that apparently no great harm resulted, perhaps, however, there was not as much known about this as was desirable. In the case of house drains, however, arrangements had to be provided for encouraging a current of air through the drains in a particular direction. This was done by providing low level inlets and high level outlets, but in connection with

this some trapping had to be done. First of all it should be said that all drains should be trapped off from cesspools or sewers by what is known as a "disconnecting" trap. Now this trap is not an ordinary trap placed on the line of drain, it is something more than that. It must have communication with the open air on the upper side. Water in a trap would absorb foul air on the one side, and give it off on the other, therefore, an ordinary trap on the line of a drain would be no real security against the passage of foul air from cesspools or sewers into the house drains. But by the admission of fresh air on the upper side of a trap, not only any foul gases which might pass through the trap were diluted and rendered comparatively harmless, but a low level inlet ventilator was provided. He was often struck when examining students as to the distinctive feature of a disconnecting trap, by their being unable to describe it. A disconnecting trap did not so much depend upon its form as upon its means for communicating with the open air. Many people thought that house drains should ventilate the sewers, but a little experience of the horrible smells resulting in the house drains would convince anyone that the sewers should be ventilated by themselves, and that the house drains should have their own special arrangements. First of all the house drains should be shut off from the sewer by a disconnecting trap which should have fresh air in communication with it. It was usual to put a disconnecting trap in a manhole, but a different sort of disconnecting trap could be put in where manholes are not provided. The lecturer here fully illustrated the various differences between the disconnecting traps by diagrams, and pointed out that in all these traps there was a little drop between the lip of the trap and the surface of the water; the object of that was that water passing through a trap is checked in its velocity, and unless some assistance in the way of extra fall was given, the water would back up and cause the drain to be surcharged for some distance up its course. The position of low level inlets to drains was of great importance, because often the disconnecting trap with its fresh air inlet had to be placed in front of a house, and, in the case of very small properties, near windows or doorways. It was usual in these cases to carry the inlet a little further away and put it in the side wall, or even to carry it a little higher than the wall above head level so that it might not become offensive in the case of temporary back draughts. The lecturer then explained the various flap valves used in connection with the low level inlet ventilators.

The outlet ventilator usually took the form of a ventilating pipe at the head of drains, the point farthest from the sewer. Generally for the sake of cheapness a soil pipe was made to do the double duty of a soil pipe and

ventilating pipe. If the soil pipe was at the head of a drain it might be all that was wanted, but if not another ventilator must be provided. A ventilating pipe should be one that would not rust. It might be of iron with strong joints, but if of iron it should be either galvanised or glass lined, which was one of the latest inventions, or at the least coated with Angus Smith's composition. If these precautions were not taken, the rust flakes would fall down inside and gradually stop up the bottom. His experience showed that 90 per cent. of the iron piping put in as ventilators after a considerable time became absolutely useless. He constantly found pipes in connection with old buildings quite full with rust. An iron ventilating pipe should be similar as to its construction, although perhaps not quite so thick as a soil pipe, but its joints should be sufficiently wide in its socket to enable it to be either packed with composition of sulphur, salomonic and iron filings, or else run with molten lead and caulked. Ventilating pipes might also be made of lead, and many people preferred them. Personally he was beginning to prefer the iron: lead was so liable to "buckle" up. Besides it was heavy and required a great deal of fixing to the wall, and it was liable to become "kinked." The position of the top of a ventilating pipe is important, but there was no absolute rule. Sanitation was not an exact science, and many of the things he had been explaining to them were empirical; but a good way to form an idea as to where a ventilating pipe should finish was to see the way smoke issued from the top. It should be at least ten feet above the eaves or windows, and fifteen feet away sideways. A pipe should be taken up as directly as possible, because angles in ventilating pipes reduced the velocity of the air current. Ventilating pipes could be seen made to curl and twist round eaves. He had seen one which had eleven angles in it; it was hardly necessary to say such pipes did not ventilate much.

One minor equipment of house drainage remained to be mentioned, namely, gulleys. A gully should be one of two kinds, either self-cleansing or not self-cleansing. The self-cleansing one (figs. 7 and 8) should be used for slop water, or anything which may become polluted.

The non-self-cleansing one (figs. 8A, 9, and 9A), or cesspool kind, should be one which would catch grit and retain it from passing down drains. Gulleys for foul water should hold the smallest amount of water

FIG. 7.
YARD GULLEYS.

consistent with the area of the outlet pipe, but should be big enough to allow anything which would come down sinks to pass away. In dealing with gulleys they had to consider and determine whether they ought to be self-cleansing or of the cesspit kind, and then they would know exactly the kind to use. Fig. 8 is the "Accomo" Yard Gully, which is made in three or more pieces, each of which turns independently of the others, allowing the grating, side inlets, and outlet to be turned in any direction, dispensing with the use of bends.

FIG. 8.—THE "ACCOMO" YARD GULLY.

The bell trap (fig. 10) was the old form of gulley, but this was now nearly extinct. It was most objectionable because it gave so little trappage and had a loose top, which on removal would open the trap.

Then there were grease traps. For a long time he had set his face against these, and used to think it was better to provide some special means of cleansing a greasy drain coming from a scullery sink, but now he was converted to grease traps if of a right size and properly fitted up. A grease trap might be quite a cesspool in itself. It might be too big, it might retain a large amount of grease and keep it so long that it would fester and decompose and become a nuisance. A small grease trap was less objectionable, but these traps must be cleared regularly. One good method of getting rid of the grease was to provide a flushing gulley with a flushing rim (fig. 11)—a largish gulley—in connection with which was placed a small flushing tank. The grease went into the gulley, rose and congealed, but subsequently was got rid of by the flushing tank which was arranged to discharge about once a day. The discharge broke up the grease, washed it off, and it went down the drain. That was a convenient arrangement where a large quantity of

FIG. 8A.
SKEY'S STREET GULLY.

grease was unavoidable. Householders might remember that it was not a bad method of cleaning a gulley to empty down a pail of hot water and soda now and again; this would generally keep it quite clean. Some gulleys were made with buckets in them (fig. 9), but these were only suitable where drains had silt and gravel in them. It is inadvisable to use a bucket gulley in connection with anything foul, because it retains the foul matter instead of allowing it to pass down the drains. Gulleys for rain water pipes are very likely in summer to evaporate, and they should never be near air bricks which ventilate the spaces under floors. It had been his experience to find foul smells attributable to the rain water gulleys and the passage of foul air through the air brick.

The Lecturer then said that it was important to know how to examine the drainage of a house, and he would briefly point out how this should be conducted. First of all, one should look at the surroundings to ascertain whether there was anything which might be objectionable; and observe of course whether the dust-bins and arrangements belonging to other houses close by were in order before forming an opinion as to whether the surroundings of a house were healthy. It should be noted whether the soil pipe was outside, as it ought to be.

Then it should be ascertained whether it was ventilated, and, if so,

FIG. 9.—DEAN'S SILT GULLY.

FIG. 9A.

CROSTAS ROAD GULLY.

where the ventilating pipe finished. It would be necessary to see whether there were rain water pipes, and whether they ran into the ground or discharged into gulleys outside; the position of sinks and baths should be noted and whether the waste pipes discharged over gulleys. On the confines of the premises the signs of a disconnecting trap, or manhole must be looked for; that would suggest a ventilator to it, and if there was no manhole there might still be a trap which ought to have a ventilator. If none of these were found, suspicion would be aroused, and it would not be surprising to find several defects in the arrangements inside of the house. Then proceeding inside, the basement would be examined as to whether there were traps in the floor, whether they were connected with the drains, or were discharged over other traps outside, as should be the case. Signs of damp in the walls

BELL TRAP.

FIG. 10.

FIG. 11.

FLUSHING GREASE TRAP.

should be looked for, and it should be ascertained if the sinks were trapped; also whether the apparatus of the water closets was of a good kind, and if the woodwork was easily removed so that the apparatus could be examined; also whether the flushing water was laid on separately from that supplying the sinks and baths. It would

be necessary to know if the baths and lavatory basins had traps, and if the waste pipes were rightly laid. Also if there were anti-siphonage pipes, if one water closet was above another, whether the cisterns were properly placed, so that they could be cleaned, and what the connections were with the various appliances. If the drains required to be tested it could be done by a

FIG. 12.

WATT'S ASPHYXIATOR.

a smoke rocket, or by a machine, such as those shown in figs. 12, 13, and 14. With the smoke test it would have to be carefully noticed

FIG. 13.—JONES'S SMOKE MACHINE.

whether smoke came out anywhere. During the test a point must be made of being inside the house to see whether there was any

FIG. 14.

BURN BROS.' MACHINES FOR APPLYING SMOKE TESTS TO DRAIN.

escape or smell. If after the smoke test and all the examinations it was

necessary to be sure of the condition of the drains, then it would be

FIG. 15.—JONES'S EXPANDING SCREW DRAIN AND PIPE STOPPER.

necessary to test them with water, first plugging the pipe with a stopper or

FIG. 16.—JONES'S BAG DRAIN AND PIPE STOPPER.

expanding bag, as shown in figs. 15, 16, and 17. Probably before this point was reached, however, it would be possible to form a pretty good idea of what the drainage was like.

FIG. 17.—BURN BROS.' BAG DRAIN STOPPER.